Bisection auctions

Summary of the dissertation
"Bisection auctions"
by Elena Grigorieva

A central issue in economics is allocation of goods. One of the best ways to allocate goods is to sell them using free market mechanisms and an auction is such a mechanism. Traditionally, art objects, collectibles and antiques have been sold by means of auctions. In the last few years, due to modern information technologies both the range and the total value of goods sold by auctions have grown enormously. The increasing popularity of auctions has raised a lot of questions on the appropriate design of auctions.

When it comes to the comparison of different auction designs, various performance measures can be used. Allocative efficiency (i.e. maximization of social welfare) is one of criteria for comparison. This criterion is especially important when it concerns the sale of a publicly held asset to the private sector. Much research has been done on how to set the rules of the auction so that allocative efficiency is achieved despite the fact that buyers act based on self-interest. Due to the Revelation Principle, the focus has mainly been on direct revelation. In the private value environment the challenge is considered to be solved since in the VCG direct mechanism truth-telling is a weakly dominant strategy and the equilibrium results in an efficient allocation.

By construction, implementation of an equilibrium strategy in the VCG mechanism requires buyers to reveal complete and exact preference information. It has been recognized however that this is an undesirable feature of a mechanism for several reasons. First, buyers may prefer not to reveal information on their valuations for reasons of privacy or long-term competitiveness. Second, determining one's valuation with a precision up to the last digit can be computationally demanding. Finally, the full revelation of buyer' preferences may require a prohibitive amount of communication.

Recognition that full expression of preferences is undesirable has led to an interest in auctions where bidders need not reveal their information entirely but only partially. The challenge (also in this thesis) is to design auctions that are able to find an efficient allocation, preferably in weakly-dominant strategies, without asking bidders to reveal complete information on their

preferences.

In this thesis, we analyze to what extend we can limit information revelation while still preserving full efficiency of an allocation. We proposed a new iterative auction, the bisection auction, and show that for the case of integer valuations the bisection auction, while being fully efficient, requires elicitation of much less information than the known efficient auctions. We show that in the bisection auction only a small fraction of players' valuation information needs to be revealed before the efficient allocation can be determined. In fact for the integer setting we design an iterative implementation of the single-item VCG mechanism that finds the outcome with minimal information revelation from buyers. For the case of continuous valuations, we prove that limited information revelation is incompatible with the efficiency requirement. We show what level of revelation can be achieved if we are satisfied with a particular level of efficiency.

Part I of the thesis is devoted to the setting of integer valuations where we introduce and analyze the bisection auction. In Chapter 2 we present a full game-theoretic analysis of the bisection auction and show that the proposed auction is strategically equivalent to the Vickrey auction and the English auction, implying that also in the bisection auction telling the truth is a weakly dominant strategy and the equilibrium results in an efficient allocation.

While being strategically equivalent to the Vickrey and English auctions the bisection auction outperforms them in terms of information revelation and associated communication. The superiority of the bisection auction is shown in Chapter 3 where we compare the expected amount of information transmitted by players in these three auctions. In Chapter 4 we investigate how much communication the bisection auction needs compared to any other auction that finds the Vickrey outcome. We introduce a measure for comparison that resembles stochastic dominance. With respect to this measure we prove that for the case of two players the bisection auction requires the least communication.

Given the reported advantages of the bisection auction it seems quite attractive to put it to practice. In order to investigate the practical usefulness of the bisection auction we conduct a laboratory experiment where we test and compare bidding behavior and outcomes of the bisection, Vickrey and En-

glish auctions. In particular, we check whether bidders follow the dominant truth-telling strategy and how their behavior changes over time as they gain more experience. Data show that in general the bisection auction performs better than the Vickrey auction and only in terms of some measurements worse than the English auction. Chapter 5 describes the experiment and reports the results.

In Part II in the context of continuous valuations we investigate the allocative efficiency of query auctions. In Chapter 6 we show that in the continuous setting query auctions, being a good tool for reducing preference revelation, do not allow achieving full allocative efficiency. We prove that full efficiency can only be achieved at the expense of an infinite running time of a query auction for almost all realizations of valuations. So the question arises: what price (in terms of running time) has to be paid for getting a desired level of approximate efficiency? In the last two chapters of the thesis we give an answer to this question. In Chapter 7 we introduce a very wide class of query auctions, general bisection auctions. We show the existence of ex post equilibrium, called the bluff equilibrium, and prove that the inefficiency in the equilibrium is inevitable. In Chapter 8 we are concerned with the trade-off between running time and allocation efficiency in the bluff equilibrium of a family of general bisection auctions, called c-bisection auctions. We show that, by choosing the appropriate parameter c, we can achieve arbitrary small inefficiency in equilibrium, while the running time of the auction in equilibrium is finite for all realizations of valuations.